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13. ABSTRACT (Maximum 200 words)

Elevating the receiving antenna in projects to monitor movements and behaviors of right whales, *Eubalaena glacialis*, in critical habitats will increase range and efficacy. This was accomplished by mounting the antenna and receiver on an aerostat (tethered balloon). At altitudes of 200 ft or greater, ranges of 15-20 miles can be expected. This project evolved to include other applications, and demonstrated the use of aerostats for carrying antenna arrays, instrument packages, sensors, and cameras to altitudes of several thousand feet. An emerging area in the field of environmental technology has been identified.

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Final Report

GRANT #: N00014-98-1-0853

PRINCIPAL INVESTIGATOR: James H. W. Hain

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Box 721 3 Water Street
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GRANT TITLE: An aerostat/elevated antenna component to aid VHF radiotelemetry and tracking of right whales in critical habitats.

AWARD PERIOD: 15 August 1998 - 14 August 2001

OBJECTIVE: Knowledge about distribution, movements, and behavior of right whales, *Eubalaena glacialis*, on their only known calving grounds in coastal waters of the southeastern United States will aid in mitigation of human impacts (including ship strikes) on this endangered species. VHF radio tracking is one tool applied to this task. Affixing the receiving antenna to a shore-based aerostat (tethered balloon) at altitudes of 300-500 ft will increase range and logistical efficacy.

APPROACH: During February 1999, a 29-ft, 1500 cubic-foot helium-filled aerostat was deployed from Amelia Island, Florida. A 10-ft Comet Model GP-6 omni-directional antenna was attached to the belly of the aerostat. An Advanced Telemetry Systems (ATS) R4000 receiver was placed in a weather-tight container and mounted on the payload rack under the balloon. The audio signal from the receiver was relayed via cable into an amplifier/speaker at the ground station. The telemetry transmitter or "beacon" used in calibration and ranging tests was supplied by HABIT Research Ltd., and had a transmission frequency of 148.438 MHz, a pulse width of 20 msec, a pulse rate of 2/sec, and a power output of 50mW. To calibrate receivers and test reception ranges, researchers positioned the beacon at various locations and distances along the shore, and from a chartered vessel.

As part of this project, high-rise buildings were also evaluated as possible antenna sites. In this case, a 10-element Yagi antenna, a 4-element Yagi, and a 2-element "H" style compact antenna were evaluated. As in the above, the beacon was positioned at various locations and ranges, including aboard a 41-ft Coast Guard patrol vessel.

In Year I of the project (the 1998-1999 season) whale occurrence was anomalous, and few right whales occurred on these grounds. Only a single right whale was tagged. This tag ceased transmission prior to the start of these trials.

In Year II of the project (the 1999-2000 season), for a variety of reasons, VHF radio-tagging of right whales in these waters was discontinued. While no work took place in the southeast US, we continued exploring applications, including alternate uses, of the aerostat and remote-sensing capabilities.

The project broadened and evolved, and included a number of diverse components - all aimed at exploring and developing this potential research tool.

In October 2001, a new opportunity and new direction was presented. In collaboration with the Canadian Department of Fisheries and Oceans, a project to video right whales and potential human impacts in the Bay of Fundy was begun.

ACCOMPLISHMENTS: Based on preliminary trials during February 1999, both aerostat- and building-based antenna sites have merit for tracking right whales and receiving telemetered data. From altitudes/elevations of ≥ 200 ft, ranges of 15-20 nmi can reasonably be expected. Utilizing an aerostat/antenna system that can be repositioned, perhaps in combination with antenna sites on tall buildings, will aid in tracking and monitoring a whale as it moves along the coast.

In the evolved and restructured project, during trials during July 2002 from the dock at the Woods Hole Oceanographic Institution, as well as from a boat in Vineyard Sound, substantial advances and developments in application of the aerostat to remote video recording/monitoring of whale behavior took place. From altitudes of 300-500 ft, a high-resolution video recording was made by a camera on the balloon's payload rack and transmitted via 2.4 GHz wireless to the monitoring station below. Field work will take place in the Bay of Fundy from 12-31 August 2002.

CONCLUSIONS: Specific to monitoring of tagged whales and other species, the capability has been demonstrated. Should this line of research be revitalized, some work with directional antennas would be required. This capability has application to newer monitoring and tracking approaches, including cell-phone technology and relay and storage of telemetered data packets.

The aerostat can be deployed from shore or from a vessel. Work is continuing in this area.

On the broader scale, progress in science is closely linked to advances in platforms, instrumentation, and technology. The past decade has seen major advances in development of manned submersibles, remotely operated vehicles (ROVs), autonomous unmanned vehicles (AUVs), satellite-based systems, and others. One intriguing area in the field of environmental technology, yet to be developed to full potential, is that of lighter-than-air platforms. Aerostats - tethered balloons capable of carrying antenna arrays, instrument packages, sensors, and cameras to altitudes of several thousand feet - are emerging as a valuable tool in addressing a wide variety of scientific and environmental tasks. Through the R&D on this project, the capability has been convincingly demonstrated and a glimpse of the future provided.

SIGNIFICANCE: Two Navy facilities are adjacent to the right whale calving and wintering grounds in the coastal waters of the southeastern US: the submarine base at King's Bay, Georgia, and the Navy base at Mayport, Florida. The Navy has been an active and effective partner in right whale recovery and conservation efforts through its support of research, and through its participation in the Coastal America Program, and the right whale Early Warning System. In the past few several years, the Navy has established itself as a leader and model for these types of efforts.

The R&D achieved under this project (both the deployment and use of aerostats, as well as remote-monitoring initiatives) will have wide application, not only to telemetry and monitoring of endangered large whales, but to other species as well. Additionally, aerostats may have wide application as camera/video platforms, and as platforms for other sensor packages.

PATENT INFORMATION: n/a

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PUBLICATIONS, ABSTRACTS, REPORTS, AND PRESENTATIONS:

Hain, J.H.W. 2002. Lighter-than-air platforms (blimps and aerostats) for oceanographic and atmospheric research and monitoring. Fifth International Airborne Remote Sensing Conference, 21-24 May 2002, Miami, Florida.

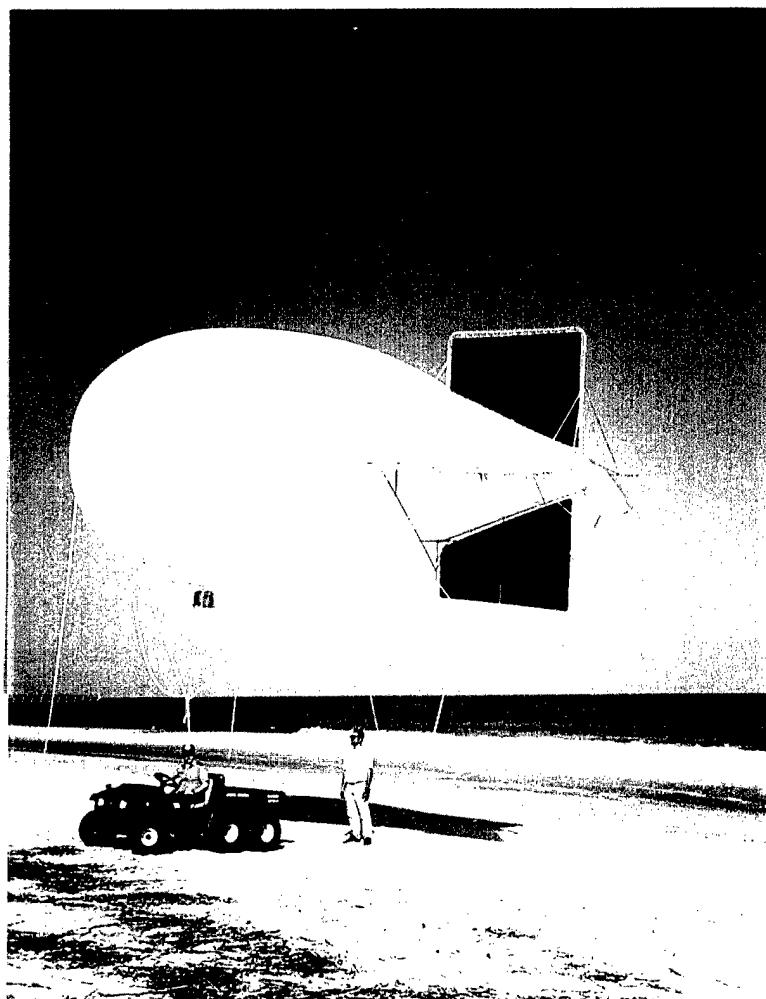
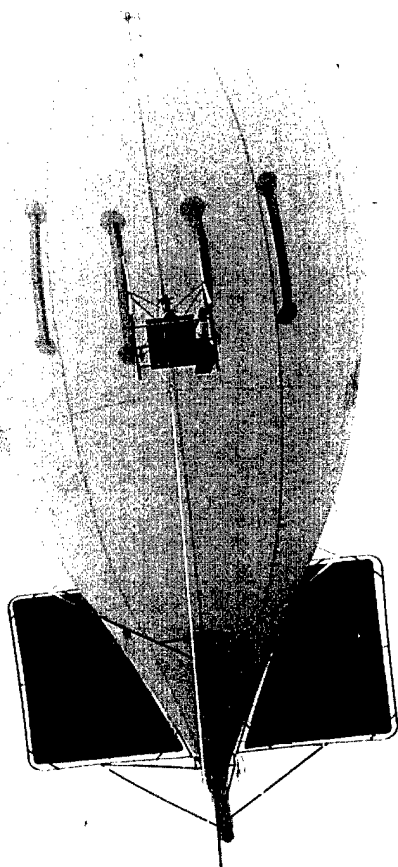
Hain, J.H.W. 2000. Lighter-than-air platforms (blimps and aerostats) for oceanographic and atmospheric research and monitoring. Proceedings Oceans2000 MTS/IEEE Conference, 11-14 September 2000, Providence, Rhode Island.

Conley, K. 1999. Navy testing: tethered aerostat balloon to enhance right whale tracking program. *Encompass* 5(1): 5

Hain, J.H.W. 1999. Update on the application of airships and aerostats to whale and habitat research. Paper # 99-3902, 13th AIAA Lighter-Than-Air Systems Technology Conference, 28-30 June 1999. Norfolk, Virginia.

Hain, J.H.W. 1999. Shore-based tracking of right whales: Phase I. Presentation to the Southeastern U.S. Implementation Team for the Recovery of the North Atlantic Right Whale, 6 May 1999. Brunswick, Georgia.

Hain, J.H.W. 1999. Shore-based tracking of right whales in coastal waters of northeast Florida: I. Aerostat R&D and ranging trials for shore-based antenna sites. Progress report submitted to Office of Naval Research, Arlington, Virginia, 20 April 1999. 13 pp.



Under ONR Award # N00014-98-1-0853, an aerostat (tethered balloon) was developed to elevate the receiving antenna for VHF radio-tagged right whales in critical habitats. The project further demonstrated the use of aerostats for carrying antenna arrays, instrument packages, sensors, and cameras to altitudes of several thousand feet. An emerging area in the field of environmental technology has been identified.